



Mark Scheme (Results)

January 2014

IAL Chemistry (WCH02/01)

Unit 2: Application of Core Principles of Chemistry

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.
- Mark schemes will indicate within the table where, and which strands of QWC, are being assessed. The strands are as follows:
 - i) ensure that text is legible and that spelling, punctuation and grammar are accurate so that meaning is clear
 - ii) select and use a form and style of writing appropriate to purpose and to complex subject matter
 - iii) organise information clearly and coherently, using specialist vocabulary when appropriate

Using the Mark Scheme

Examiners should look for qualities to reward rather than faults to penalise. This does NOT mean giving credit for incorrect or inadequate answers, but it does mean allowing candidates to be rewarded for answers showing correct application of principles and knowledge. Examiners should therefore read carefully and consider every response: even if it is not what is expected it may be worthy of credit.

The mark scheme gives examiners:

- an idea of the types of response expected
- how individual marks are to be awarded
- the total mark for each question
- examples of responses that should NOT receive credit.

/ means that the responses are alternatives and either answer should receive full credit.

() means that a phrase/word is not essential for the award of the mark, but helps the examiner to get the sense of the expected answer.

Phrases/words in **bold** indicate that the meaning of the phrase or the actual word is **essential** to the answer.

ecf/TE/cq (error carried forward) means that a wrong answer given in an earlier part of a question is used correctly in answer to a later part of the same question.

Candidates must make their meaning clear to the examiner to gain the mark. Make sure that the answer makes sense. Do not give credit for correct words/phrases which are put together in a meaningless manner. Answers must be in the correct context.

Quality of Written Communication

Questions which involve the writing of continuous prose will expect candidates to:

- write legibly, with accurate use of spelling, grammar and punctuation in order to make the meaning clear
- select and use a form and style of writing appropriate to purpose and to complex subject matter
- organise information clearly and coherently, using specialist vocabulary when appropriate.

Full marks will be awarded if the candidate has demonstrated the above abilities.

Questions where QWC is likely to be particularly important are indicated (QWC) in the mark scheme, but this does not preclude others.

Section A (multiple choice)

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 1 | B | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 2 | B | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 3 | A | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 4 | A | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 5 | D | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 6 | D | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 7 | B | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 8 | D | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 9 | B | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 10 | A | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 11 | C | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 12 | A | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 13 | A | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 14 | D | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 15 | C | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 16 | A | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 17 | C | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 18 | D | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 19 | C | | 1 |

| Question Number | Correct Answer | Reject | Mark |
|-----------------|----------------|--------|----------|
| 20 | C | | 1 |

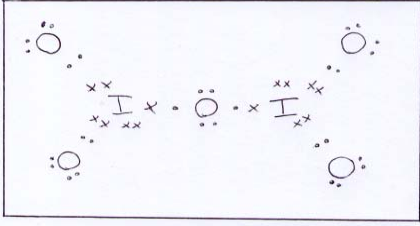
TOTAL FOR SECTION A = 20 MARKS

Section B

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|---|--------|----------|
| 21(a)(i) | (No because) The oxidation number of iodine in HIO_3 and I_2O_5 is +5/5+/V OR The oxidation number +5/5+/V remains the same. | Yes | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|------------------|---|--------------------|----------|
| 21(a)(ii) | To remove the water formed OR To prevent the 'back'/reverse reaction/to favour the right hand side/ to move the position of the equilibrium to the right/ to prevent I_2O_5 reacting with water OR To stop hydrolysis of iodine pentoxide | Water of hydration | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-------------------|--|---|----------|
| 21(a)(iii) | $\text{I}_2\text{O}_5 \rightarrow \text{I}_2 + 2\frac{1}{2}\text{O}_2$ Allow multiples/fractions Allow also the use of \rightleftharpoons . Ignore state symbols even if incorrect. Ignore temperatures. | Oxygen gas on both sides of the equation. | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--|--------|------|
| 21(a)(iv) |  <p>Double-bonded oxygens at the 4 corners, each with 2 lone pairs (1)</p> <p>Iodine to have 12 electrons and the central oxygen to be single-bonded with two lone pairs (1)</p> <p>Alternative diagrams with dative covalent bonds instead of double bonds to the oxygen, but then the oxygen would have three lone pairs, could be allowed for one mark.</p> <p>Allow one mark for correct diagram with all dots or all crosses</p> <p>Allow dots and crosses to be other way round, • for I and X for O.</p> <p>Lone pairs do not necessarily have to be clearly paired.</p> | | 2 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|---|-----------------------|------|
| 21(a)(v) | <p>105° - 107° (1)</p> <p>Pyramidal (1)</p> <p>Ignore trigonal, or alternative spellings of, or triangular before pyramidal</p> | Bipyramidal planar | 2 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--|-------------------------------------|----------|
| | In (b) any units given must be correct. Penalise once only. | | |
| | TE throughout | | |
| 21(b)(i) | (0.01 x 0.0216 =) 2.16 x 10 ⁻⁴ /0.000216 (mol) | 2.2 x 10 ⁻⁴ / 0.00022 | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|------------------|---|--------|----------|
| | IGNORE SF except 1SF. Penalise once only in (b)(ii), (iv), (v) and (vii). | | |
| 21(b)(ii) | 4.32 x 10 ⁻⁴ /0.000432 (mol) Allow 4.3 x 10 ⁻⁴ /0.00043 (mol) Allow TE from (b)(i) x 2 Allow any SF except 1 | | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-------------------|---|--------|----------|
| 21(b)(iii) | (0.04 x 0.02 =) 8.0 x 10 ⁻⁴ /0.00080 (mol) Allow 1SF here only. | | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|------------------|---|--------|----------|
| 21(b)(iv) | (8.0 x 10 ⁻⁴ - 4.32 x 10 ⁻⁴ =) 3.68 x 10 ⁻⁴ (mol) Allow 3.7 x 10 ⁻⁴ /0.00037 Allow TE from (b)(iii) ans - (b)(ii) ans Allow any SF except 1 | | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--|--------|----------|
| 21(b)(v) | 1.84 x 10 ⁻⁴ /0.000184 (mol) Allow 1.85 x 10 ⁻⁴ /0.000185/ 1.8 x 10 ⁻⁴ /0.00018 Allow TE from (b)(iv) ans ÷ 2 Allow any SF except 1 | | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|------------------|---|--------|----------|
| 21(b)(vi) | $I_2O_5 + 5CO \rightarrow I_2 + 5CO_2$ Allow multiples/fractions Ignore state symbols even if incorrect | | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-------------------|--|--------|----------|
| 21(b)(vii) | $(1.84 \times 10^{-4}) \times 5$ (1) $\times 24 = 2.208 \times 10^{-2} / 0.02208$ (dm ³) (1) Allow TE from (b)(v) and or b(vi) Allow any SF except 1 Correct answer no working (2) Allow answer in cm ³ but the unit must be given eg 22.08 cm ³ | | 2 |

| Question Number | Acceptable Answers | Reject | Mark |
|--------------------|---|-----------------------------|----------|
| 21(b)(viii) | Repeat the experiment (to get concordant titres)/ Divide solution into (equal) samples before carrying out titration/ divide the gas into (equal) samples before carrying out titration. IGNORE: Use a larger volume of gas/Use a weaker concentration of thiosulfate /Use more accurate equipment | Just 'repeat the titration' | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|---|---|----------|
| 21(c)(i) | (cars have a) Catalytic converter ALLOW Other suitable modifications which refer to more efficient combustion OR Use of hydrogen as a fuel or solar power Or use of electric cars. | Just 'car converted to run on other fuels which contain carbon' Just 'catalyst' Just 'more fuel efficient cars' | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|------------------|--|---|----------|
| 21(c)(ii) | The amount of CO₂ produced (on combustion) is equal to the amount of CO₂ absorbed (during photosynthesis) (1) Biofuel/ any suitable biofuel example such as bioethanol/ biodiesel/ suitable description of source such as "ethanol produced from sugar" (1) ALLOW Hydrogen produced using renewable resources Stand alone marks | Just 'carbon' Just 'Ethanol' Fuel cells | 2 |

TOTAL FOR QUESTION 21 = 19 MARKS

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--|---|----------|
| 22 (a) | (Fe ₂ O ₃ + 2Al →) Al ₂ O ₃ + 2Fe Allow products in either order. | Fe ₂ / Fe ²⁺ / Fe(II) | 1 |

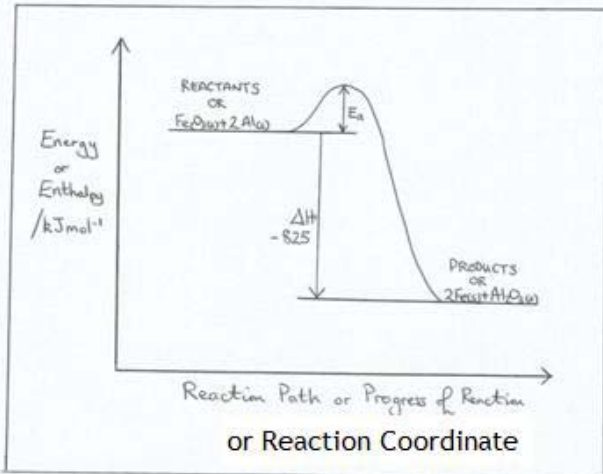
| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|---|--------|----------|
| 22 (b) | (use of) 159.6 (g mol ⁻¹) (1) (34.0 ÷ 159.6 =) 0.213 (mol) (1) (0.213 × 2 × 27 =) 11.502/11.50/11.5 (g) (1) Answer alone scores 3 If units are given, they must be correct. Ignore sf except 1 ALLOW (use of 56 for Fe so Fe ₂ O ₃ =) 160 (g mol ⁻¹) (1) (34.0 ÷ 160 =) 0.2125 (mol) (1) (0.2125 × 2 × 27 =) 11.475/11.48/11.5 (g) (1) | | 3 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|---|--|----------|
| 22(c) | Heat (in an oven)/heat (over Bunsen burner)/ heat (to constant mass). | Just 'desiccator' Temp <100°C Burn/warm Drying agents Leave to dry | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--|--|----------|
| 22(d) | To ensure complete reaction /(solids) so must be well-mixed for reactants to come into physical contact/ more surface area in contact. ALLOW More collisions of particles IGNORE Make it easier for the reactants to mix | Just 'to increase the rate of reaction' Just 'both reactants are present in solid form' Any reference to the generation of energy. | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|------------------|--|---|----------|
| 22(e) (i) | White light/white powder/ White smoke / White flame. | Just 'light' 'bright light' White ppt Colourless flame | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-------------------|---|--------|----------|
| 22(e) (ii) | Magnesium oxide/MgO Allow magnesium nitride/Mg ₃ N ₂ Allow equation to produce MgO, e.g. $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$ If name and formula given then both must be correct Ignore state symbols. | | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|---|---|------|
| 22(e)(iii) |  <p>Labelled y axis (kJ mol^{-1})</p> <p>The x axis need not be labelled but if labelled must be correct (1)</p> <p>If units are given on the axis they must be correct</p> <p>Labelled reactants above products (1) Exothermic change of -825 shown (1) Activation energy (1)</p> | <p>Enthalpy change / heat Time on the 'x' axis</p> <p>Mg/O₂</p> | 4 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|---|--|------|
| 22(e)(iv) | <p>(provides the) activation energy/ (provides the) energy for the reaction to occur/heat for the reaction to occur/ overcome the energy barrier</p> <p>Allow this to be written on the diagram</p> | <p>Decreases E_a Just 'to initiate reaction' Acts as a catalyst</p> | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--|--|----------|
| 22(e)(v) | (Chemically) changed by the reaction/ (it is) changed into MgO/ Used up (by the reaction) Allow doesn't lower activation energy | Just 'it reacts' Provides alternative routes or pathway. Does not speed up the reaction Just 'it takes part in the reaction'. | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|------------------|--|---|----------|
| 22(e)(vi) | (Once reaction is started it provides) enough energy to be self-sustaining/ energy only needed at the start as the reaction is exothermic | Chain Reaction Just 'highly exothermic reaction' | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|---|-------------------------------------|----------|
| 22(f) | It may ignite at any time/delay in the reaction/molten metal may be ejected | Just 'explosion' Flammable/ fire | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|---|--|----------|
| 22(g) | The iron is melted/molten/liquid (and joins the two pieces of metal/railway line) | Melt Aluminium Just 'melt the metal' Just 'melt the railway lines' | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|---|---|----------|
| 22(h) | Aluminium is readily available/abundant/cheap/easy to handle/easy to store/ Al_2O_3 has a low density so floats (and avoids contaminating the weld) OR Reverse argument/other metals may not react and release enough heat (to melt the iron)/other metals are difficult to store | Al does not corrode Other metals are too exothermic. | 1 |

TOTAL FOR QUESTION 22 = 18 MARKS
TOTAL FOR SECTION B = 37 MARKS

Section C

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--|-------------------|----------|
| 23(a) | C ₆ H ₈ O ₃ Allow elements in any order. | Any other answers | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--|---|----------|
| 23(b) | (Secondary) alcohol/Hydroxyl OR Alkene/Carbon-Carbon double bond OR Enol/ether | C-OH/ Just 'OH Group' Primary alcohol C=C Just 'double bond' Ester | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--|---------------------------------------|----------|
| 23(c)(i) | ROH + Na → RO ⁽⁻⁾ Na ⁽⁺⁾ + ½H ₂ (1) Allow multiples Ignore state symbols even if incorrect Effervescence/Fizzing/Bubbles OR Sodium dissolves/disappears/ decreases in size OR White solid forms (1) Stand alone marks | RNaO White ppt | 2 |

| Question Number | Acceptable Answers | Reject | Mark |
|------------------|---|-------------|----------|
| 23(c)(ii) | ROH + PCl ₅ → RCl + POCl ₃ + HCl (1) Ignore state symbols even if incorrect Steamy /misty / white and fumes/gas (1) Stand alone marks Allow PCl ₃ O | White smoke | 2 |

| Question Number | Acceptable Answers | Reject | Mark |
|-------------------|--|---|----------|
| 23(c)(iii) | <p>(HCl poses the greater risk – No credit but must be stated for the second mark)</p> <p>(because it is)toxic/corrosive/poisonous/reference damage to skin (1)</p> <p>Not enough hydrogen produced/ hydrogen produced only slowly (so won't catch fire) (1)</p> | <p>Harmful/ ozone depletion/ Flammable Just 'acidic' Just 'dangerous'</p> | 2 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--|---|----------|
| 23(d)(i) | <p>Agent: sodium dichromate((VI)) / $\text{Na}_2\text{Cr}_2\text{O}_7$/ potassium dichromate((VI))/ $\text{K}_2\text{Cr}_2\text{O}_7$ (1)</p> <p>sulfuric acid/H_2SO_4 (1)</p> <p>If name and formula are given, both must be correct.</p> <p>Conditions: Distillation (1) Allow 'Fractional distillation'</p> <p>Acidified dichromate/ H^+ and $\text{Cr}_2\text{O}_7^{2-}$ scores 1 mark Allow the acid as a reagent or as a condition. Acid can be conc. or dilute</p> | <p>KMnO_4</p> <p>Any other acids</p> <p>Reflux/ Just 'heat'</p> | 3 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--|--|------|
| * 23(d) (ii) | (infrared radiation causes) stretching/ bending/changes in bond polarity/bond vibration (1) different bonds absorb different IR (frequencies/wavelength/wavenumber)/ different peaks for different groups (1) compare absorption with database / data booklet (1) | Molecular vibration Bonds broken | 3 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|--|---|------|
| *23(e) | <p>Point 1: (Alkanes) London Forces/ Dispersion forces/van der Waals' forces (1)</p> <p>Point 2: (Arises) – instantaneous dipole/momentary imbalance in electron density (1)</p> <p>Point 3: which induces dipole in adjacent molecule (and results in attraction) / description of induction (1)</p> <p>Ignore reference to atoms/molecules</p> <hr/> <p>Point 4: (Alcohols) Hydrogen bonds (1)</p> <p>Point 5: (Arises) – oxygen's higher electronegativity creates dipole/large difference in electronegativity (1)</p> <p>Point 6: Bond is attraction between (lone pair of electrons on) O of one molecule and H of another molecule (1)</p> <hr/> <p>Point 7: London forces are weaker than hydrogen bonds (1)</p> <p>Allow "alkanes intermolecular force weaker (than that of alcohols)" for point 7</p> | <p>Just 'Id-Id' Any other forces in combination</p> <p>Any reference to permanent dipoles loses points 2 & 3</p> <p>London Forces</p> | 7 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|---|-------------------------|----------|
| 23(f) | Unique fragmentation/ different fragmentation/ different peak pattern | Just 'different masses' | 1 |

| Question Number | Acceptable Answers | Reject | Mark |
|-----------------|---|--------|----------|
| 23(g) | Polymers have low volatility/ do not bind to receptors in nose/ Polymers do not have an aroma/ Polymer formation does not involve the 'aroma' molecules/ The chemicals causing the aroma are not affected (by the enzyme) | | 1 |

TOTAL FOR SECTION C = 23 MARKS

TOTAL FOR PAPER = 80 MARKS

